AERIAL REFUELING WITH A DRONE

In the cockpit with the first aircrew ever to refuel in flight from an uncrewed tanker

BY JAN TEGLER | PHOTOS COURTESY OF BOEING

AT 12:46 PM CT ON THE AFTERNOON OF JUNE 4, 2021 pilot Lt. William "Krieger" Peabody and naval flight officer Lt. David "Poon" Babka did something no one else had done. They plugged their VX-23 F/A-18F's refueling probe into a basket trailing from a prototype version of the U.S. Navy's ground-breaking uncrewed tanker, the Boeing MQ-25 Stingray.

Pilot Lt. William "Krieger" Peabody and naval flight officer Lt. David "Poon" Babka plug in to the MQ-25's refueling basket on the afternoon of June 4, 2021, making history as the first flight crew ever to tank from an uncrewed aircraft.

Three hundred twenty pounds of JP-5 flowed from an Aerial Refueling Store (ARS) pod mounted under the prototype, known as "T1" to the Super Hornet, marking the first ever aerial refueling between a crewed aircraft and an uncrewed tanker.

MQ-25 is the Navy's future air wing tanker, intended to relieve F/A-18s of this extra task, saving wear and tear on the Super Hornets acting as "buddy tankers"—a role they're not particularly well suited to—and preserving airframe life.

The Navy is buying 72 MQ-25s for $3.1 billion with a goal of having them operating from carrier decks along with their crewed counterparts by 2025. A team from Naval Air Systems Command has spent eight years working toward the new capability, with Boeing's uncrewed tanker having been selected by the service in late summer 2018.

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The MQ-25 will also provide the Navy with as yet undefined intelligence, surveillance, and reconnaissance capabilities.

T1, the sole Stingray prototype, rendezvoused with Peabody and Babka after just 25 flights. The first-ever uncrewed-crewed aerial refueling flight generated a lot of press but not much has been said about what it was like to refuel from a drone tanker. We asked the people directly involved to describe it.

The View from the Rhino

"From behind, all you can see is the engine," Peabody says. "The wings essentially blend in with the sky. They're so thin you can't see them. It took a while to get close to MQ-25."

Peabody and Babka say the Stingray's somewhat stealthy shape that lacks a vertical tail surface makes it hard for human eyes to see in some circumstances. Both explained that when MQ-25 is flying straight and level, it has a very flat profile that makes it hard to spot. When the drone banks, lifting a wing on either side, it becomes much easier to see, Peabody says.

"Once it's at an angle of bank you can see its large wingspan. When you're co-altitude with it and straight and level, it's so flat it's hard to see."

Peabody, a 2020 graduate of the Naval Test Pilot School with combat experience flying from the USS George HW Bush (CVN-77) to both Iraq and Syria in support of Operation Inherent Resolve, and Babka, a 2019 NTPS graduate with three deployments aboard two carriers under his belt, took off from Mid America Airport in Mascoutah, Illinois (adjacent to Scott AFB) just east of St. Louis, climbing after the MQ-25 that whistled down runway 32—right ahead of them for hour-plus morning and afternoon sorties.

It was the first time a "Rhino," the well-known nickname for the Super Hornet, had flown with T1. Months of planning went into the flight, with modeling and simulation work done by Boeing and NAVAIR engineers to determine how the two aircraft would interact.

From the rear cockpit, Babka noted that determining whether the MQ-25 was heading toward you or away from you initially wasn't easy. "Determining aspect is difficult," he says. "With the F/A-18, you can see the tails and based on where the tails are you know exactly which direction it's heading."

Peabody compared the experience to a scene from the movie Monty Python's Holy Grail. "It's like the scene where the knight is charging the castle over and over but he's never getting any closer. That's what it felt like joining on the MQ-25. You look at it and you say, 'I don't think I'm getting closer. I don't think I'm getting closer.' And all of a sudden it's right there!"

The Boeing MQ-25 Stingray will be the first uncrewed aircraft ever to fly from U.S. Navy aircraft carriers. Expected to be operational by 2025, the MQ-25's main mission will be aerial refueling, taking over the task from air wing Super Hornets.

The VX-23 test pilots were precluded from using their Super Hornet's APG-79 radar to find the Stingray during the test flights, but both say they think fleet aviators will learn how to spot the drone with their eyes pretty quickly.

Flying formation with the Stingray

Preparing to fly in closer proximity to an uncrewed aircraft than any crewed military aircraft customarily does required intense planning, Peabody says.

"What sort of wake models did we have? What sort of turbulence would there be from T1? And how would the bow wave of the Super Hornet affect T1?"

All of these considerations were extensively modeled and simulated, but no one had actually flown the kind of close formation you fly when aerial refueling from another aircraft with MQ-25. Peabody and Babka would be the first to get up close and personal with the 51-foot-long, 11-foot-tall, 75-foot-wingspan drone.

Despite that, they didn't have "any qualms" Babka says. "I've done a lot of tanking behind a few different platforms, and I didn't think this aircraft would be any different."

But there are differences, including the Stingray's "closed-loop" control system, so-called because the drone is programmed to fly and respond to preset commands almost immediately.

The result is an aircraft that flies precisely, like a robot, Peabody notes.

"One of the things that came out of the test was that we need to make the MQ-25 fly more like a human," he adds.

In other words, the MQ-25 is a good flight lead but it adjusts its flight path rapidly and rigidly, making it hard to fly in company with in some circumstances.

"I thought flying off the robot was a little challenging," Peabody explains. "If I'm going to go to 30 degrees angle of bank, as a human I can't nail it. So you'll slow down your roll rate to slowly approach 30 degrees. But if MQ-25 is told to go to 30 degrees angle of bank, it can just go there and nail it."

Human pilots don't fly to the numbers, constantly adjusting their flight paths in less rigid ways to maintain position or maneuver. As Babka says, human flight leads "never fly on autopilot," especially in close formation.

"We need to make MQ-25 a little more open loop. But we can't make it completely open loop because it is essentially flying on autopilot. There are some things that I think the engineering team can come up with to make it a little smoother when it's executing state changes."

The testers say the NAVAIR and Boeing teams are working on making MQ-25 react more like a crewed aircraft to ease its integration into air wings.

"Meaning that it's not going to try to correct aggressively back to its commanded state," Babka explains. "Maybe the control gain and control laws are tuned so that it takes a little bit longer

and it acts a little bit more like a human would."

Plugging-In

When Peabody and Babka joined on the Stingray, they began to experiment with how "Salty Dog 123" reacted to the MQ-25 and how the uncrewed tanker reacted to the F/A-18F.

Approaching the tanker on the morning flight, the VX-23 aircrew planned to try "dry plug-ins," connecting their refueling probe to the Stingray's basket without receiving fuel. As theory became practice, more of the questions about how MQ-25 and the Super Hornet would react to each other were answered.

"We had to consider what the basket characteristics would be like," Peabody says. "Will it be stable? Will it be oscillating?"

What they found was reassuring.

"It's smooth," Peabody reveals. "The wake is barely perceptible. We even flew directly behind the MQ-25's exhaust, like less than 10 feet behind it. We were staring down the engine and [turbulence] was no more than driving down a gravel road."

Babka compared the experience to refueling from the Omega Air K-707 tankers the Navy contracts for aerial refueling. Equipped with refueling pods mounted near their wingtips, the Omega K-707s don't generate much turbulence.

"The air out there is super smooth," Babka attests. "MQ-25 does that but we're right behind it. So that's a huge difference from tanking behind a Rhino."

Sam Platt (foreground) is Boeing's chief test pilot for the MQ-25. He directs a team of five air vehicle operators—the personnel who plan and manage the autonomous flight of the Stingray—in support of the drone's test and development program. Here, he does a preflight inspection of T1 at Mid America Airport in Mascoutah, Illinois.

THE AVO'S PERSPECTIVE

While Peabody and Babka handled the VX-23 Super Hornet, Boeing's Sam Platt oversaw the flight of the MQ-25 on June 4 as the Stingray's Air Vehicle Operator, or AVO.

AVOs are the uncrewed tanker's operators. They don't remotely pilot the MQ-25, which flies autonomously. They devise the mission plan that defines how the drone will perform a flight—in this case, the first-ever uncrewed/crewed aerial refueling.

Platt, a retired Naval Flight Officer who flew as an F-14 Radar Intercept Officer and as a test Weapons Systems Operator in F/A-18Fs, is Boeing's chief test pilot for the MQ-25. He directs a team of five AVOs who support the Stingray test and development program while teaching Navy AVOs how to operate the drone and pioneering procedures to fly the MQ-25.

"As AVOs we command test scripts, which provide specific commands to the aircraft system," Platt explains. "AVOs monitor aircraft performance and control the performance limits that are set for each phase of testing. We also manage the path of the aircraft in relation to our test area."

"In addition to fully autonomous operations, we can command specific flight parameters manually, like airspeed and altitude." This "manual override" capability comes in handy for example, "when Air Traffic Control requires us to take a specific vector for traffic," he adds.

Platt and his team of AVOs operated the Stingray from a Ground Control Station (GCS) in a trailer at Mid America. He says AVOs will operate MQ-25s from similar GCSs aboard aircraft carriers when the tanker becomes operational.

The AVOs began with a preflight brief and walk-around inspection of the MQ-25 then started the drone and performed preflight systems, weather and airspace checks. Satisfied, they taxied the Stingray to the runway, and with the chase aircraft already airborne, gave a takeoff command from the GCS.

"The aircraft autonomously throttled up and took off, following its mission plan to an administrative point in our airspace. The chase aircraft joined up en route. As planned, the F/A-18F followed five minutes later, and joined the flight in formation."

Following takeoff, the MQ-25 largely flew its mission plan autonomously but with manual commands from Platt for each step of the refueling. Once operational, those steps will be automated. Meanwhile Peabody and Babka joined on the tanker and tested its wake in various positions with the drogue extended.

Then Platt "commanded the retraction of the hose and drogue to stow it, allowing the F/A-18 pilot to move forward to where the basket was to evaluate the wake in the fuel transfer zone directly behind T1—requiring the pilot to maneuver the F/A-18 at times within about 20 feet of T1."

After making two successful dry plug-ins, the test team deemed it "safe to proceed" and transferred fuel on the third and fourth plug-ins.

Platt says his biggest task "was the management of the flight in the airspace, to ensure we kept within the test area coordinated with the FAA."

Like Peabody and Babka, he didn't think about the historical significance of what he'd just done until afterwards.

"I leaned on my training and deferred the real excitement and happiness," Platt says. "I was honored to have the opportunity to be AVO on this strong team for this amazing achievement."

Peabody found another pleasant surprise.

"It was quiet! That's one of the biggest differences. When you're behind a Super Hornet with those GE 414 engines, you can barely hear yourself think. Behind T1 there's very little noise in the cockpit. The airflow is smooth. It's a pretty benign experience."

So benign, in fact, that Peabody was able make the dry plug-in on his first attempt. The aircrew performed plug-ins with Stingray in level flight and in turns, emulating the maneuvers most often done during two types of air wing tanking: mission tanking and recovery tanking.

"Recovery tanking is all around the boat, staying as close to 'mom' as you can so you're always tanking at an angle of bank," Peabody says.

He adds that positioning the Super Hornet behind the MQ-25, about 10 feet below the drone and slightly to the left of its center line to line up with its ARS pod "felt pretty natural."

Plug-ins were done at 12,000 feet and 220 knots and 15,000 feet and 200 knots according to the Super Hornet crew. That's 30 to 50 knots slower than the normal speed at which Rhinos and other air wing aircraft refuel, making the evolution a bit more challenging. But as more refueling test flights are carried out, plans call for T1 and the other prototypes to fly at the standard 250 knots more familiar to fleet aviators, making refueling easier because "the jet handles more crisply at 250," Peabody observes.

Krieger and Babka say they think air wing pilots will rapidly adjust to refueling from uncrewed tankers after a few kinks have been worked out, noting how stable the Stingray's basket is and how easy it is to plug into.

Babka notes that one of the big achievements of the historic flight was proving that the digital ARS pod used by the Stingray worked.

"The ARS pod has an analog control head that is used with the Super Hornet. The engineers had to take those analog controls and make them digital inside MQ-25's vehicle management system. That was a big test—to make sure that the analog to digital transition is working correctly."

Will fleet aviators like it? "Yes, I think this will be pretty good," Peabody says, adding that the MQ-25's basket was "very stable." He thinks the uncrewed tanker will become "the preferred tanking platform for the fleet."

Babka agrees that fleet aviators will become accustomed to the MQ-25 pretty quickly but explains that some questions remain.

Though Stingrays will stick to their mission plans, AVOs can make limited changes to their flight profiles including altering heading, altitude, and airspeed if the need arises.

"But what you have to think about with MQ-25 is what happens when it needs to get back to its mission plan?" He explains that the AVO "needs to be cognizant of how and where" MQ-25 will return to its mission plan "to ensure a smooth transition from manual commands back to the mission plan."

Ultimately, the MQ-25 will have to build trust with fleet aviators like any other aircraft new to air wings, Peabody stresses.

"Let's say it's night, it's scary and I bolter. I need to get aboard because I have no divert options. There's one place I can get gas and the MQ-25 is it. We've been there and understand that. We're providing that understanding for the test team, not losing focus on the lives at stake. This isn't a science fair project. It needs to operate for the warfighter and be reliable."

Making History

Asked if either of them thought about the history they were making while taking fuel from the MQ-25, Peabody and Babka say they really didn't think about it until after they got back on deck.

"Obviously this isn't the same as breaking the sound barrier for the first time, but it is a pretty awesome milestone to have been a part of," Babka admits. "It's also awesome to be able to share that with the test team that has worked really hard over the past eight years to get to this point."

"I come from a single seat background (flying the F/A-18E), so if I'm behind a tanker, no one's watching me," Peabody quips. "If I screw up, no one really knows. But we had video cameras rolling for the test, so I was thinking, 'I can't screw this up because people are watching.' But it feels good to have done this." ✈